# SNA LAB EXPERIMENT 2

Name: Chirag Krishna Ingale

MIS: 612203068

Div: 1

Batch: S4

Subject: SA(Sensors and Automation)

Aim: To understand the working principle of LVDT

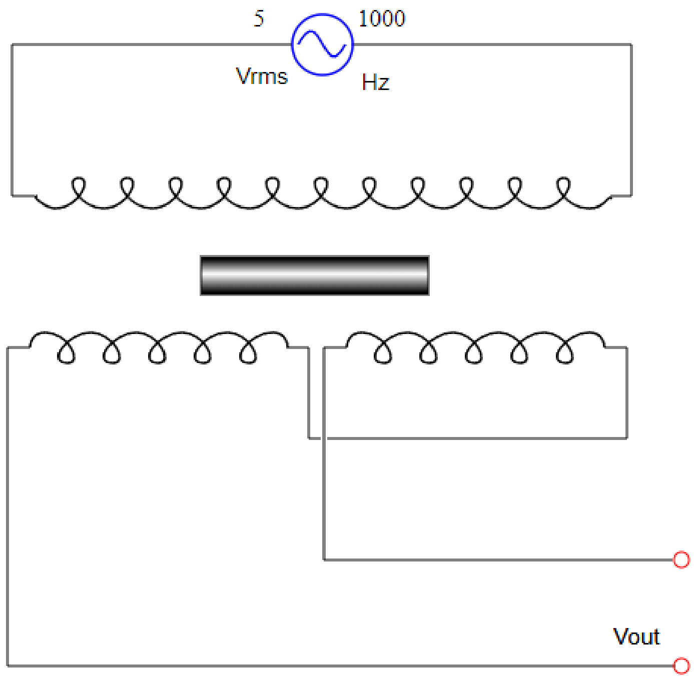
Objectives:

1. Study the relation between core displacement and output of LVDT
2. Understand the effect of change in supply frequency on LVDT performance
3. Understand the effect of change in excitation (supply ) voltage on LVDT performance

Theory:

LVDT is made of two main components: the monable armature and the outer transformer windings. LVDT consists of 3 windings. Centre one is Primary winding while the other two are secondary windings. The secondaries are identical and placed symmetrical about the primary. The secondary coils are connected in series-opposition.

Moving element of LVDT is called core. It is a cylindrical armature made of ferromagnetic material. It is free to move along the axis of the tube. At one end, the core is coupled to an object whose displacement is to be measured, while the other end moves freely inside the coil's hollow bore.




Working:

An alternating current is connected to the primary. This current must be of appropriate amplitude and frequency. It is also called as **Primary Excitation**. The frequency is usually in the range 1 to 10 kHz. This current causes a voltage to be induced in each secondary proportional to its mutual inductance with the primary. While the frequency of induced voltage is same as that of excitation frequency, its amplitude varies with the position of the iron core.

As the core moves, the voltages induced in the secondaries changes due to change in mutual inductance. The coils are connected in series but in opposite phase , so that the output voltage is the difference between the two secondary voltages. When the core is exactly at central position, i.e at equal distance from the two secondaries, equal but opposite voltages are induced in these two coils, so the output voltage is zero.

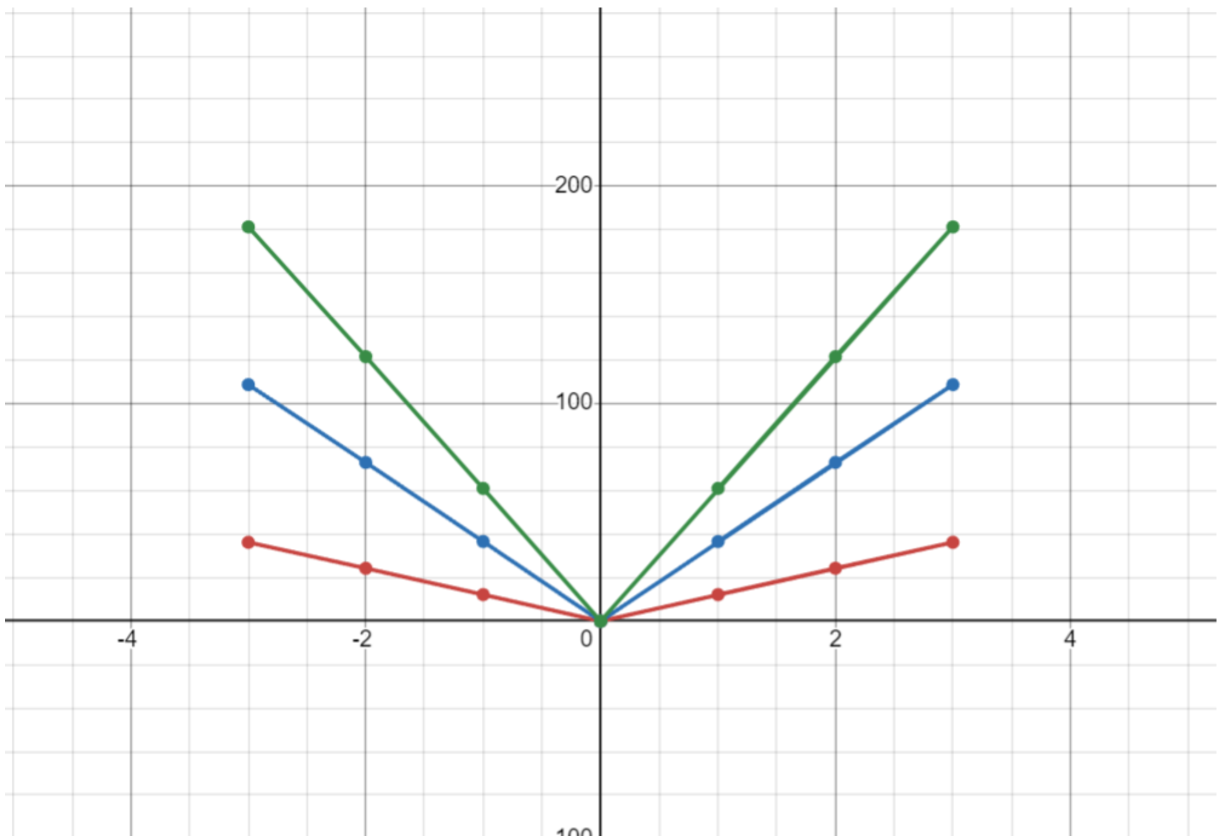
When the core is displaced in one direction, the voltage in one coil increases with respect to the other, causing the output voltage to increase from zero to a maximum value. This voltage is in phase with the primary voltage. When the core moves in the other direction, the output voltage also increases from zero to a maximum value, but the phase is opposite to that of the primary. The magnitude of the output voltage is proportional to the distancen moved by the core. The phase of the voltage indicates the direction of the displacement.

Observations:

If only frequency is changed keeping input voltage as 7 and nuber of turns as 1000:

| | | | | | | |
|---|---|---|---|---|---|---|
| Frequency | 1000 | 1000 | 3000 | 3000 | 5000 | 5000 |
| Coordinates | x | y | x | y | x | y |
| | -3 | 36.27 | -3 | 108.82 | -3 | 181.37 |

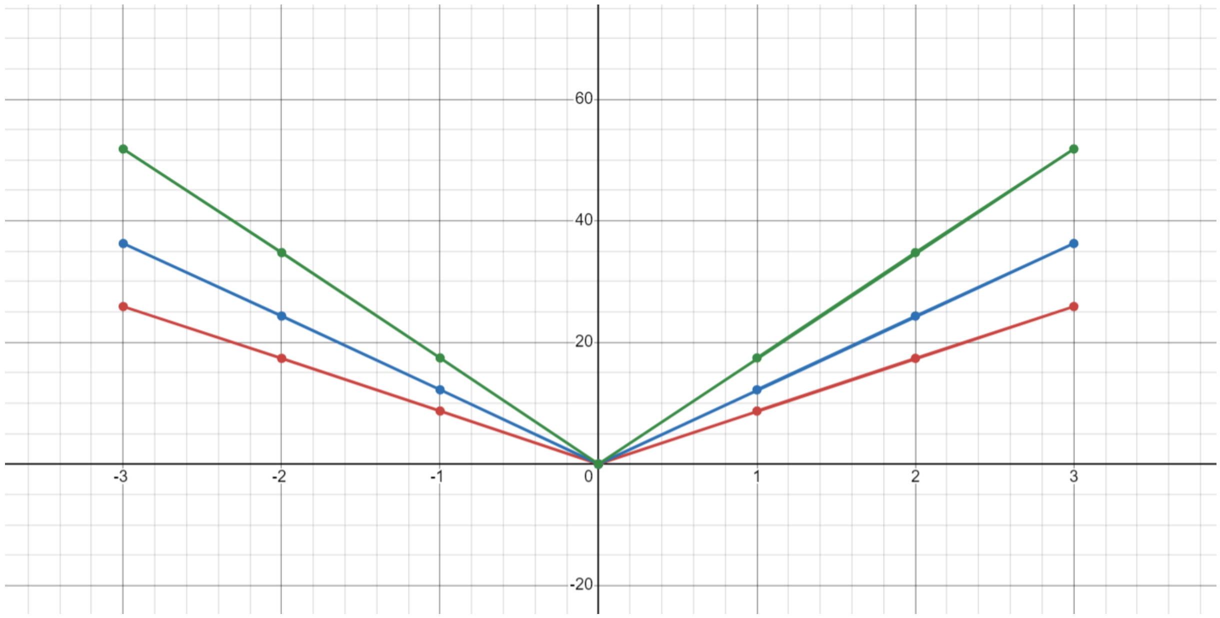
| | | | | | | |
|---|---|---|---|---|---|---|
| | -2 | 24.34 | -2 | 73.01 | -2 | 121.68 |
| | -1 | 12.21 | -1 | 36.64 | -1 | 61.07 |
| | 1 | 12.21 | 1 | 36.64 | 1 | 61.07 |
| | 2 | 24.34 | 2 | 73.01 | 2 | 121.68 |
| | 3 | 36.27 | 3 | 108.82 | 3 | 181.37 |




Frequency 1000=red, 3000=blue, 5000=green

If only input voltage is changed keeping frequency and nuber of turns both as 1000:

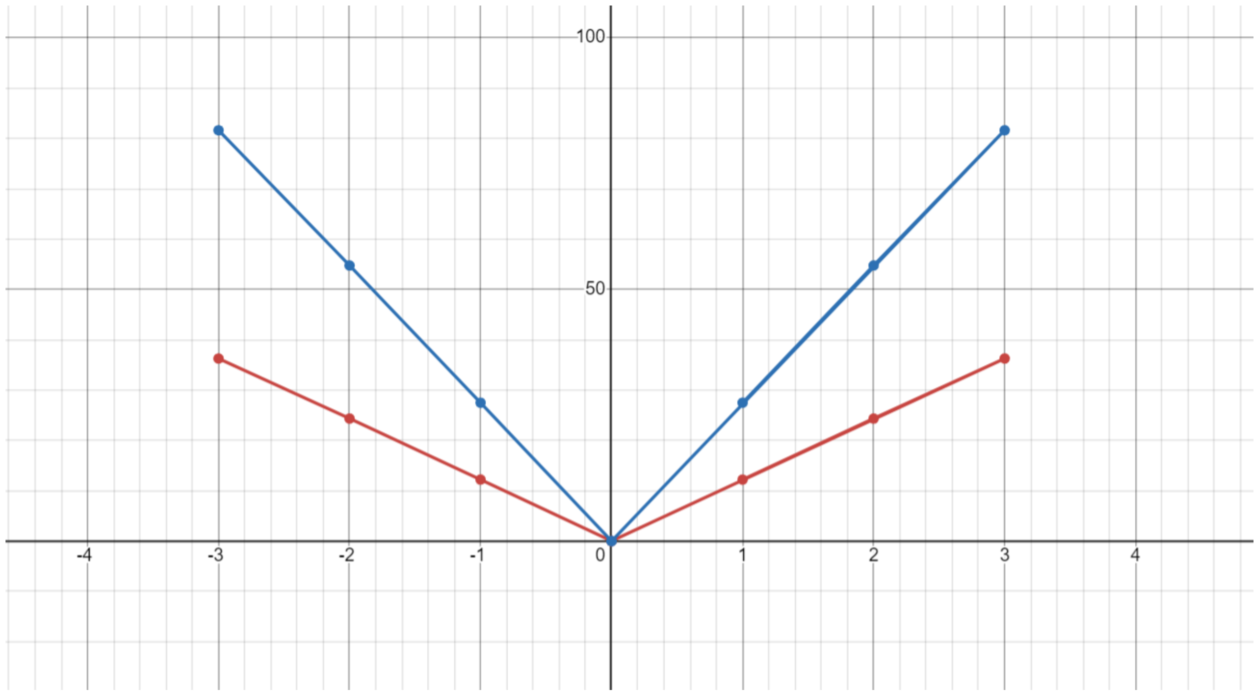
| | | | | | | |
|---|---|---|---|---|---|---|
| Input Voltages | 5 | 5 | 7 | 7 | 10 | 10 |
| Coordinates | x | y | x | y | x | y |
| | -3 | 25.91 | -3 | 36.27 | -3 | 51.82 |
| | -2 | 17.38 | -2 | 24.34 | -2 | 34.77 |
| | -1 | 8.72 | -1 | 12.21 | -1 | 17.45 |
| | 1 | 8.72 | 1 | 12.21 | 1 | 17.45 |
| | 2 | 17.38 | 2 | 24.34 | 2 | 34.77 |
| | 3 | 25.91 | 3 | 36.27 | 3 | 51.82 |




Input Voltage 5=red, 7=blue, 10=green

If only number of turns is changed keeping input voltage as 7 and nuber of turns both as 1000:

| Input Voltages | 1000 | 1000 | 1500 | 1500 |
|---|---|---|---|---|
| Coordinates | x | y | x | y |
| | -3 | 36.27 | -3 | 81.62 |
| | -2 | 24.34 | -2 | 54.76 |
| | -1 | 12.21 | -1 | 27.48 |
| | 1 | 12.21 | 1 | 27.48 |
| | 2 | 24.34 | 2 | 54.76 |
| | 3 | 36.27 | 3 | 81.62 |




Number of Turns 1000=red, 1500=blue

Formula:

$$Vout = fIp(4\pi NpNs\mu 0bx/3mlog(ro/ri))(1-(x^2/2b^2))$$

Where,

f =supply frequency (user selectable)

Ip=primary current = Vin/R

Where Vin (Vrms) is user selectable and R is the coil resistance ( 10 K Ohm)

Np=number of primary turns (user selectable)

Ns=number of secondary turns ( half of primary turns)

ro/ri=Ratio of outer and inner radii of the coil system ( = 2)

x=displacement of the core form null (from actual core postion)

μ0=permeability of space (4π10^-7h/m)

b = length of primary winding (= 20mm)

m = length of secondary winding (= 10 mm)

Conclusion:

The experiment taught us that changing the supply frequency affects how well the LVDT performs. When the frequency goes up, so does the output voltage and sensitivity of the LVDT. This matches what we expected based on theory, showing that the device reacts differently to frequency changes.
We also found that the excitation voltage directly influences how the LVDT behaves. If we increase the

excitation voltage, the LVDT output goes up too. This is important to know for real-world applications where keeping the excitation voltage stable and calibrated is crucial for accurate measurements.
Furthermore, we learned that the number of turns in the coil affects how well the LVDT works. Changing the number of turns impacts the sensitivity and linearity of the LVDT. When we increase the number of turns, the output voltage also goes up.
So, by studying these different factors, we gained a better understanding of how they affect the LVDT's output voltage.